CLAIMS

What is claimed is:

1. A fiber optic module for coupling photons between an optoelectronic device and an optical fiber, the fiber optic module comprising:

a base having a slot and a plurality of pin holes, the base for mounting the fiber optic module in a system for coupling photons between an optoelectronic device and an optical fiber;

a printed circuit board (PCB) inserted into the slot substantially perpendicular to the base, the PCB having a plurality of pins inserted into the plurality of pin holes and an optoelectronic device for communicating with an optical fiber using photons, the optoelectronic device having terminals coupled to the PCB; and

a shielded housing coupled to the base, the shielded housing encasing the PCB for reducing electromagnetic interference (EMI).

2. The fiber optic module of claim 1 for coupling photons between an optoelectronic device and an optical fiber wherein, the PCB further comprises:

electrical components coupled between the optoelectronic

device and the plurality of pins on a first side of the PCB, the electrical components for controlling the optoelectronic device, and

a ground plane coupled to a second side of the PCB for reducing electro-magnetic fields generated by the electrical components.

3. The fiber optic module of claim 1 for coupling photons between an optoelectronic device and an optical fiber, the fiber optic module further comprising:

an optical block coupled to the optoelectronic device, the optical block having a first lens to couple photons between the optoelectronic device and an optical fiber.

4. The fiber optic module of claim 3 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the optical block has a pair of optical block posts for alignment, and

the fiber optic module further comprises:

an optical fiber alignment plate having a pair of optical block alignment holes coupled to the optical block posts for coupling in alignment the alignment plate to the optical block, the alignment plate having an

optical opening to allow passage of photons and a fiber optic post on a back side for coupling in alignment an optical fiber with the optical opening.

5. The fiber optic module of claim 4 for coupling photons between an optoelectronic device and an optical fiber, the fiber optic module further comprising:

a nose coupled to the base, the nose for receiving an optical fiber connector and holding an optical fiber substantially fixed and aligned with the optical opening of the alignment plate.

6. The fiber optic module of claim 4 for coupling photons between an optoelectronic device and an optical fiber, the fiber optic module further comprising:

a nose shield surrounding the nose for reducing electromagnetic interference.

7. The fiber optic module of claim 3 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the first lens of the optical block is one of an aspheric lens, a ball lens, or a GRIN lens.

8. The fiber optic module of claim 3 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the first lens of the optical block is for launching photons into an optical fiber from the optoelectronic device.

9. The fiber optic module of claim 8 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the first lens is a collimating lens to steer the photons.

10. The fiber optic module of claim 8 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the first lens is a symmetric lens to provide additional modes of coupling of photons.

11. The fiber optic module of claim 3 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the first lens of the optical block is a focusing lens for receiving photons from the optical fiber and coupling them

to the optoelectronic device.

12. The fiber optic module of claim 3 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the optoelectronic device is coupled substantially perpendicular to the printed circuit board, and

the optical block further comprises:

a reflective surface for reflecting photons between the optoelectronic device and the first lens; and

a second lens for coupling photons between the optoelectronic device and the reflective surface.

13. The fiber optic module of claim 12 for coupling photons between an optoelectronic device and an optical fiber, wherein,

photons are to be received from an optical fiber,

the first lens of the optical block is a collimating lens for receiving photons from the optical fiber and directing them towards the reflective surface,

the reflective surface reflects photons received by the first lens towards the second lens and the optoelectronic device, and

the second lens of the optical block is a focusing lens

for focusing photons from the reflective surface into the optoelectronic device.

14. The fiber optic module of claim 13 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the optoelectronic device is a photodetector.

15. The fiber optic module of claim 12 for coupling photons between an optoelectronic device and an optical fiber, wherein,

photons are to be launched into an optical fiber,

the first lens of the optical block is a collimating lens for receiving photons from the optoelectronic device and directing them towards the reflective surface,

the reflective surface is for reflecting photons received from the first lens and directing them towards the second lens and the optical fiber, and

the second lens of the optical block is a focusing lens for focusing photons from the reflective surface into an optical fiber.

16. The fiber optic module of claim 15 for coupling photons between an optoelectronic device and an optical fiber,

wherein,

the optoelectronic device is an emitter.

17. The fiber optic module of claim 16 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the emitter is a vertical cavity surface emitting laser (VCSEL).

18. The fiber optic module of claim 12 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the reflective surface is a boundary surface providing total internal reflection for the photons to be reflected.

19. The fiber optic module of claim 12 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the reflective surface is a mirror coated surface to reflect the photons.

20. The fiber optic module of claim 12 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the reflective surface is an optical grating surface to scramble photo-modes and to reflect the photons.

21. A fiber optic transceiver for coupling photons between optoelectronic devices and optical fibers, the fiber optic transceiver comprising:

a base having a first slot near one side, a second slot near an opposite side of the first slot, a first plurality of pin holes near the one side and a second plurality of pin holes near the opposite side, the base for mounting the fiber optic transceiver in a system for coupling photons between an optoelectronic device and an optical fiber;

a first printed circuit board (PCB) inserted into the first slot substantially perpendicular to the base, the first PCB having a plurality of pins inserted into the first plurality of pin holes and a first optoelectronic device for communicating with a first optical fiber using photons, the first optoelectronic device having terminals coupled to the first PCB;

a second PCB inserted into the second slot substantially perpendicular to the base, the second PCB having a second plurality of pins inserted into the second plurality of pin holes and a second optoelectronic device for communicating with a second optical fiber using photons, the second

optoelectronic device having terminals coupled to the second PCB; and

a shielded housing coupled to the base, the shielded housing encasing the first PCB and the second PCB to reduce electromagnetic interference (EMI).

22. The fiber optic transceiver of claim 21 for coupling photons between optoelectronic devices and optical fibers wherein,

the first PCB further comprises:

first electrical components coupled between the optoelectronic device and the plurality of pins on a first side of the first PCB, the first electrical components for controlling the first optoelectronic device, and

a first ground plane coupled to a second side of the first PCB for reducing electro-magnetic fields; and,

the second PCB further comprises:

second electrical components coupled between the optoelectronic device and the plurality of pins on a first side of the second PCB, the second electrical components for controlling the second optoelectronic device, and

a second ground plane coupled to a second side of the second PCB for reducing electro-magnetic fields.

23. The fiber optic transceiver of claim 22 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first PCB and the second PCB are inserted into the first slot and the second slot respectively such that the first electrical components are between the first ground plane and the shielded housing and the second electrical components are between the second ground plane and the shielded housing to reduce electrical crosstalk.

24. The fiber optic transceiver of claim 21 for coupling photons between optoelectronic devices and optical fibers, the fiber optic transceiver further comprising:

an optical block coupled to the first optoelectronic device and the second optoelectronic device, the optical block having a first lens to couple photons between the first optoelectronic device and a first optical fiber and a second lens to couple photons between the second optoelectronic device and a second optical fiber.

25. The fiber optic transceiver of claim 24 for coupling

photons between optoelectronic devices and optical fibers, wherein,

the optical block has a pair of optical block posts for alignment, and

the fiber optic transceiver further comprises:

an optical fiber alignment plate having a pair of optical block alignment holes coupled to the optical block posts for coupling in alignment the alignment plate to the optical block, the alignment plate having an optical opening to allow passage of photons and a pair of fiber optic posts on a back side for coupling in alignment a pair of optical fibers with the optical opening.

26. The fiber optic transceiver of claim 25 for coupling photons between optoelectronic devices and optical fibers, the fiber optic transceiver further comprising:

a nose coupled to the base, the nose for receiving an optical fiber connector and holding a pair of optical fibers substantially fixed and aligned with the optical opening of the alignment plate.

27. The fiber optic transceiver of claim 26 for coupling photons between optoelectronic devices and optical fibers, the fiber optic transceiver further comprising:

a nose shield surrounding the nose for reducing electromagnetic interference.

28. The fiber optic transceiver of claim 24 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first lens and the second lens of the optical block are of the set of aspheric lenses, ball lenses, or GRIN lenses.

29. The fiber optic transceiver of claim 24 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first lens of the optical block is a focusing lens for receiving photons from an optical fiber and coupling them to the first optoelectronic device and the second lens of the optical block is a focussing lens for launching photons into an optical fiber from the second optoelectronic device.

30. The fiber optic transceiver of claim 29 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first lens is an asymmetric lens to steer the photons.

31. The fiber optic transceiver of claim 29 for coupling photons between optoelectronic devices and optical fibers, wherein,

the lens is a symmetric lens to provide additional modes of coupling of photons.

32. The fiber optic transceiver of claim 29 for coupling photons between an optoelectronic devices and optical fibers, wherein,

the first optoelectronic device is a photodetector, and

the second optoelectronic device is an emitter.

33. The fiber optic transceiver of claim 32 for coupling photons between an optoelectronic devices and optical fibers, wherein,

the emitter is a vertical cavity surface emitting laser (VCSEL).

34. The fiber optic transceiver of claim 24 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first optoelectronic device is coupled substantially perpendicular to the first printed circuit board and the

second optoelectronic device is coupled substantially perpendicular to the second printed circuit board such that the first printed circuit board and the second printed circuit board are substantially parallel to each other and the first and second optoelectronic devices nearly face each other, and

the optical block further comprises:

a first reflective surface for reflecting photons between the first optoelectronic device and the first lens;

a second reflective surface for reflecting photons between the second optoelectronic device and the second lens;

a third lens for coupling photons between the first optoelectronic device and the first reflective surface; and

a fourth lens for coupling photons between the second optoelectronic device and the second reflective surface; and

wherein,

the first lens is for coupling photons between the first reflective surface and the first optical fiber, and

the second lens is for coupling photons between the second reflective surface and the second optical fiber.

35. The fiber optic transceiver of claim 34 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first lens of the optical block is a collimating lens for receiving photons from the first optical fiber and directing them towards the first reflective surface,

the first reflective surface reflects photons received by the first lens towards the third lens and the first optoelectronic device, and

the third lens of the optical block is a focusing lens for focusing photons from the first reflective surface into the first optoelectronic device.

36. The fiber optic transceiver of claim 35 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first optoelectronic device is a photodetector.

37. The fiber optic module of claim 34 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the fourth lens of the optical block is a collimating lens for receiving photons from the second optoelectronic

device and directing them towards the second reflective surface,

the second reflective surface is for reflecting photons received from the fourth lens and directing them towards the second lens and the optical fiber, and

the second lens of the optical block is a focusing lens for focusing photons from the second reflective surface into a second optical fiber.

38. The fiber optic transceiver of claim 37 for coupling photons between optoelectronic devices and optical fibers, wherein,

the second optoelectronic device is an emitter.

39. The fiber optic transceiver of claim 38 for coupling photons between optoelectronic devices and optical fibers, wherein,

the emitter is a vertical cavity surface emitting laser (VCSEL).

40. The fiber optic module of claim 35 for coupling photons between an optoelectronic device and an optical fiber, wherein,

the fourth lens of the optical block is a collimating

lens for receiving photons from the second optoelectronic device and directing them towards the second reflective surface,

the second reflective surface is for reflecting photons received from the fourth lens and directing them towards the second lens and the optical fiber, and

the second lens of the optical block is a focusing lens for focusing photons from the second reflective surface into a second optical fiber.

41. The fiber optic transceiver of claim 40 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first optoelectronic device is a photodetector, and

the second optoelectronic device is an emitter.

42. The fiber optic transceiver of claim 41 for coupling photons between optoelectronic devices and optical fibers, wherein,

the emitter is a vertical cavity surface emitting laser (VCSEL).

43. The fiber optic transceiver of claim 34 for coupling photons between optoelectronic devices and optical fibers,

wherein,

the first and second reflective surfaces are boundary surfaces providing total internal reflection to reflect photons.

44. The fiber optic transceiver of claim 34 for coupling photons between optoelectronic devices and optical fibers, wherein,

the first and second reflective surfaces are mirror coated surfaces to reflect photons.

45. The fiber optic transceiver of claim 34 for coupling photons between optoelectronic devices and optical fibers, wherein,

the second reflective surface is an optical grating surface to scramble photo-modes of photons.

46. The fiber optic transceiver of claim 21 for coupling photons between optoelectronic devices and optical fibers, the fiber optic transceiver further comprising:

an internal shield inserted between the first PCB and the second PCB, the internal shield further reducing electrical crosstalk.

47. A method of assembling a fiber optic transceiver, the method comprising:

a) providing an optical block having lenses and reflectors for directing photons

b) coupling a transmitting optoelectronic device and a receiving optoelectronic device to the optical block

c) providing a single printed circuit board having transmit electronics and receive electronic components separated by a score; and

d) flexing the printed circuit board near the score to separate the single printed circuit board into a transmit printed circuit board and a receive printed circuit board for coupling respectively to the transmitting optoelectronic device and the receiving optoelectronic device.

48. The method of claim 47 of assembling a fiber optic transceiver, the method further comprising:

e) installing the present assembly into a shielded housing to reduce electromagnetic interference; and

f) coupling a base to the shielded housing, the base having a pair of parallel slots to couple substantially perpendicular to the transmit printed circuit board and the receive printed circuit board such that the transmit printed

circuit board and the receive printed circuit board are substantially parallel to each other.

49. The method of claim 47 of assembling a fiber optic transceiver, wherein,

the transmitting optoelectronic device and the receiving optoelectronic device are coupled substantially perpendicular to the optical block in the coupling step such that photons in the optical block are collimated, reflected, and focused to couple photons between an optical fiber and an optoelectronic device.

50. The method of claim 47 of assembling a fiber optic transceiver, wherein,

the transmitting optoelectronic device and the receiving optoelectronic device are coupled substantially perpendicular to the optical block in the coupling step such that photons in the optical block are focused, reflected, and collimated to couple photons between an optical fiber and an optoelectronic device.

51. The method of claim 47 of assembling a fiber optic transceiver, wherein,

the transmitting optoelectronic device and the receiving

optoelectronic device are coupled to the optical block in parallel to the path of photons in optical fibers in the coupling step such that photons in the optical block are focused or collimated in order to couple photons between an optical fiber and an optoelectronic device.

52. A fiber optic transceiver for transmitting and receiving photons over optical fibers, the fiber optic transceiver comprising:

a transmitter for transmitting photons,

a receiver for receiving photons,

an optical block for coupling photons between optical fibers and the transmitter and the receiver, the optical block having

a receive opening on one side of the optical block for receiving the receiver,

a transmit opening on an opposite side of the optical block for receiving the transmitter, the transmit opening staggered from the receiving opening to avoid optical crosstalk between the transmitter and the receiver,

a first lens, a first reflector and a third lens in an optical path between the receive opening and a first area for coupling photons into a first optical fiber, and

a second lens, a second reflector and a fourth lens in an optical path between the transmit opening and a second area for coupling photons into a second optical fiber.

53. The fiber optic transceiver of claim 52 for transmitting and receiving photons over optical fibers, wherein the optical block of the fiber optic transceiver further has:

a top pair of tacking holes coupling to the receive opening and the transmit opening, the top pair of tacking holes for receiving an epoxy to hold the receiver and the transmitter respectively in place.

54. The fiber optic transceiver of claim 53 for transmitting and receiving photons over optical fibers, wherein the optical block of the fiber optic transceiver further has:

a bottom pair of tacking holes coupling to the receive opening and the transmit opening, the bottom pair of tacking holes for receiving an epoxy to hold the receiver and the transmitter respectively in place.

55. The fiber optic transceiver of claim 52 for

transmitting and receiving photons over optical fibers, wherein the optical block of the fiber optic transceiver further has:

a pair of optical block alignment pins for coupling to an optical fiber alignment plate, the pair of optical block alignment pins for aligning an optical output port of the optical block to optical fibers.

56. The fiber optic transceiver of claim 52 for transmitting and receiving photons over optical fibers, wherein,

the first and fourth lenses are collimating lenses and the second and third lenses are focusing lenses.

57. The fiber optic transceiver of claim 56 for transmitting and receiving photons over optical fibers, wherein,

the second reflector is an optical grating.

58. The fiber optic transceiver of claim 56 for transmitting and receiving photons over optical fibers, wherein,

the first reflector and the second reflector are boundary surfaces providing sufficient index of refraction to provide

total internal reflection of incident photons.

59. The fiber optic transceiver of claim 52 for transmitting and receiving photons over optical fibers, wherein,

the first reflector and the second reflector are mirror coated surfaces to reflect incident photons.

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